Fermilab

Accelerator Division
EE Support Department
February 14, 1995

CONSTRUCTION PROJECT REPORT

TESLA MODULATOR DEVELOPMENT

Project Title: Tesla Modulators Number 2 and 3

Project Manager: Dan Wolff

Description of Purpose:

As part of the Tesla collaboration Fermilab and DESY will undertake, through joint agreement, the production of two 5MW modulators similar to the one (#1) already produced by Fermilab for the collaboration. The general procedures which this effort will be carried out are covered in the overall MOU of the TESLA Collaboration. The complete details governing this particular collaboration is awaiting final approval of the Fermilab directorate. DESY will provide funds for all the procurements necessary to produce the two modulators. In addition DESY will supply the Klystrons. Fermilab will provide the laboratory manpower and services for the engineering, procurement, assembly, testing, and any indirect costs associated with expenses incurred at FNAL. The time estimate to produce these two modulators is 15 to 20 months. One modulator will remain at FNAL (with its klystron) and will be used for the tests on the Tesla Injector II (RF photo injector) which are planned for 1996. This modulator will be shipped to DESY along with the Injector when both are ready (estimate early 1997). The other modulator will be shipped to DESY after full power testing with klystron.

Total Estimated Cost: $1,000,000.00 Source of Funds: DESY

Funds Obligated and Costed Through February 17, 1995: approx. $330,000.00

Cost to Complete: $770,000.00

Status of Cost and Schedule (including milestones and estimated completion date):

Project is expected to be complete at the cost estimate by July, 1996.

Issues/Problems:

None.

Proposed Corrective Action:

Not Applicable

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INTRODUCTION:

This project will allow for the construction of two modulators to be shipped to DESY as part of the Tesla collaboration. The modulators will have the following performance specifications:

1. Output pulse length: 1.4 ms at +/- 0.5% (Switch conduction time of 1.7ms) This represents a change from the original modulator built for DESY that had a switch conduction time of 2.3ms.
2. Operating pulse rate: 10 pulses per second
3. Operating Voltage: 120 kV at 92 amps (Thomson TH2104C klystron) 110 kV at 130 amps (Thomson MBK klystron)
4. Supply power: 400 VAC, 3 phase, 50 Hz
5. Cooling requirements: Low Conductivity Water (resistance > 1 Mohm cm)

6. Klystron Protection: Spark energy limited to 20 joules

7. Physical requirements:
   a. The first modulator will be built assuming the physical requirements of the Thomson TH2104C klystron (including socket and solenoid mounting).
   b. The second modulator will be built assuming the physical requirements of the Thomson MBK klystron. Since this device is in the early stages of development, the mechanical specifications will be determined later.

8. Solenoid and Filament Power Supplies:
   a. The solenoid and filament power supplies for the first modulator will be built for the Thomson TH2104C klystron.
   b. The solenoid and filament power supplies for the second modulator will be built for the Thomson MBK klystron.

9. Modulator controls, interlocks, and RF circuits:
   These circuits will be direct copies (with minor modifications) of the first Tesla modulator built at Fermilab and commissioned at DESY during March of 1994.

FY-1995 PROJECT SUMMARY:

The project is still waiting for the signed, official agreement between the two labs. However, since the agreement is imminent, a budget code has been issued and the EE Support Department has commenced ordering parts. To date about $330k of parts have been ordered.

The necessary preliminary engineering analysis of changes relating to an increase in pulse energy has been completed. Work has also progressed on updating the specifications for major items such as the high voltage capacitors and various magnetic components.

The design effort to develop a high voltage switch consisting of a number of insulated gate bipolar transistors (IGBT) connected in series has started.

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REMAINING WORK TO COMPLETE:

Work will continue on the specifications of the magnetic components, of particular import is the specification of the pulse transformer. Past experience indicates that only one manufacturer (Stangenes of California) competitively bids these type of devices. We will continue to search for other suppliers while our collaborators at DESY will try to work with an inexperienced (at building high voltage pulse transformers) European manufacturer to design and construct one unit.

Complete the design, development and testing of a high voltage IGBT switch. This is one of the more interesting aspects of this project. While preliminary investigations indicate that such a switch is possible, further development may indicate that for either technical or practical reasons such a switch may not work in this application. If the IGBT switch becomes impractical, Fermilab will construct GTO switches like the ones successfully developed and operating in the original modulator for application to these units.

As the modulator cabinets and sufficient parts become available, assembly work will commence in the A0 high bay lab area.

Remote read back, control, and system timing generation will require the assistance of the Accelerator Controls Department (Mike Shea) to build, test, and install similar equipment that was supplied with the original modulator.

Assistance will also be needed from the PBAR group (Ralph Pasquinelli) to duplicate the low level RF systems.

The A0 lab area will need its power and water capability upgraded to allow for full power testing. The building transformer has sufficient excess power so only minor modifications are needed for the additional 1 Megawatt of power needed to run both modulators simultaneously. The Mechanical Support Department is presently investigating methods of attaining the additional 200 gpm of LCW needed.

SCHEDULE OF REMAINING WORK:

4/1/95: Finish specifications of all major magnetic components.

6/1/95: Order prototype switch parts.

7/1/95: Begin assembly of modulator subsystems (when cabinet available).

10/1/95: Begin power testing of prototype switch.

1/1/96: Order parts for 2 additional switches.

2/1/96: **Begin power testing** of first modulator as a system.
This will require the completion of the Controls Department and PBAR Department efforts as described above. Also at this point .5Mw of power and 100 gpm of LCW will be needed at A0.

4/1/96: Begin power testing of first modulator with klystron.

6/1/96: Begin power testing of second modulator as a system.
If both modulators need to be powered at this time, (for example, running the RF photo injector while testing the 2nd modulator), we will need 1Mw of power and 200 gpm of LCW.

7/1/96: Begin power testing of second modulator with MBK klystron (if available).

ESTIMATE OF COST TO COMPLETE:

The estimated cost to complete this project is $770,000.00

DESCRIPTION OF THE COMMISSIONING AND PERFORMANCE OF THOSE PARTS OF THE PROJECT COMPLETED IN FY 1995:

None.

ISSUES/COMMENTS:

None.